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INVESTIGATION OF TYPHOID FEVER AT TEXARKANA, ARK.-TEX. (MILK OUTBREAK.)

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This investigation was undertaken upon the request of the representative to Congress from the first district of Texas, to the Surgeon General, Public Health and Marine-Hospital Service, and with the approval of the State boards of health of Arkansas and Texas.

Occasion is taken to express appreciation for the help and courtesies extended by the mayors, health officers, and other city officials, and by the physicians and citizens of the two cities.

SCOPE OF INVESTIGATION.

This has included a careful study of 36 cases, a sanitary survey of the cities, inspection of dairies, inspection of the public water system, bacteriological examination of water and milk; the making of Widal blood tests as an aid in diagnosis; and the examination of blood and stools from the attendants of one dairy. A blank form was used for each patient and filled out with any information having a bearing upon the possible source of infection.

POSSIBLE CAUSES.

The prevalence of typhoid fever in any community depends directly upon the chances which are offered for the contamination of food and drink with the typhoid bacillus.

The typhoid bacilli are discharged in the excreta of patients with typhoid fever during a part of the incubation period, during the period of fever and convalescence, and occasionally for years after the attack. In a small percentage of cases typhoid bacilli are found in the excreta of people who have had no apparent symptoms of the disease.

Infection may be brought into a community by means of water, milk, milk products, ice, green vegetables, raw shellfish, and other food products.

Its further spread in the community may be by direct contact to persons in intimate association with the patient, and by insects, especially flies having access to the dejecta of patients and to the food of those living in the same or neighboring houses.

Milk is a favorable culture medium for the typhoid bacillus, and when once introduced it multiplies rapidly under ordinary conditions.

There are numerous ways in which it may gain entrance in milk. At the dairy farm a person in the early stages of typhoid fever or convalescing, or suffering from an unrecognized case of the disease, may convey infection directly to the milk in handling it. Or a person nursing a patient may convey the infection to the milk. Again, infection may be carried by flies from excreta not disinfected, directly to the milk or the milk utensils. If the milk utensils are washed in water taken from a well or stream, which is contaminated by infected dejecta, the disease is thus further spread.

Milk bottles left at the home of a patient with typhoid fever may easily become infected, and if carried back to the dairy and filled before being thoroughly sterilized, may carry the infection to a different home.

The essential aim in all preventive measures against typhoid is the keeping of the dejecta of typhoid patients from the food and drink of other people. This can be accomplished in recognized cases, but a few mild cases and either temporary or chronic bacillus carriers are more than apt to escape detection.

PREVALENCE OF DISEASE.

From September 1 to November 15, 1911, there occurred in Texarkana 36 cases of typhoid fever. These cases were reported by the attending physicians at the special request of the health officers, as typhoid at present is not among the list of infectious diseases required to be reported.

Two of these cases are regarded as being imported, the disease developing within 9 days after their arrival in the city.

The remaining 34 were distributed as follows, according to the date of definite onset:

From Sept. 1–15, inclusive	2
From Sept. 16–30, inclusive	1
From Oct. 1–15, inclusive	3
From Oct. 16–31, inclusive	9
From Nov. 1–15, inclusive	19
	34

Estimating the population at 15,000 people, this gives an incidence of disease of 1 case to every 441 people.

There is no data for an accurate comparison of the number of cases occurring this year with previous years. But it would seem that there has been an unusual prevalence of the disease, at least during the period from October 15 to November 15.

The cases occurred for the most part in the better residential part of the city. Twenty-eight of the cases occurred in 28 separate homes. The remaining 6 occurred in 3 separate homes, 2 in each. In 2 of these homes both patients were taken sick within a week of each other, which suggests some common outside source of infection. In the third home the second case developed 15 days after the first case, which suggests contact with the previous case as the cause.

In general they were of mild or moderate severity, and only 1 death was reported. This gives a case fatality of 2.9 per 100, which is very low. For the most part the cases were characterized by a sudden onset.

DIAGNOSIS.

As an aid in diagnosis, 8 Widal blood tests were made, of which 5 were positive for typhoid and 3 negative. Of the 3 negative ones, 2 were not clinically typhoid, and the third was made during the first week of sickness.

Of the 5 positive ones, 2 were of a mild type, and a third had not been confined to bed at all.

In the 34 cases it is extremely improbable that any mistake in diagnosis was made; but on the other hand it is very probable that there really were more cases of typhoid or paratyphoid which were not classed as such on account of their mildness.

ANALYSIS OF CASES.

The 34 cases were distributed according to age as follows:

0–4 years, inclusive	3
5–9 years, inclusive	10
10–14 years, inclusive	9
15–19 years, inclusive	5
20–24 years, inclusive	2
25–29 years, inclusive	2
30–34 years, inclusive	1
35–39 years, inclusive	2
	34

Twenty-two, or 61 per cent, of the 34 cases were under 15 years of age. This is a high percentage and very suggestive of milk infection.

SEX.

The cases were evenly divided as to sex, 17 occurring in males and 17 in females.

CONTACT.

One case occurred in the same house as a previous case, the onset being 15 days later. This case may have been due to infection by contact.

SANITARY CONDITIONS.

In 29 of the 34 cases the house was connected with the city sewerage system and in 5 an open privy was in use. In only 2 cases could the sanitary conditions be classed as extremely bad.

DISPOSAL OF EXCRETA.

The disinfection of excreta was as follows: Efficient in 21 cases, fairly efficient in 10 cases, not efficient in 3 cases.

MILK.

Of the 34 cases, 33 gave a history of using milk as a beverage, or on cereals, or in both ways, within 30 days before the onset of sickness. One patient claimed to have used no milk at all.

Of the 33 cases using milk, 25, or 75 per cent, obtained the whole or a part of the milk from one dairy farm. Of the remaining 8 cases, 7 used milk from a second dairy and 1 from his own cows. Of these 7 cases, 3 took part of their meals at various restaurants, and while known to have used milk from the second dairy, may possibly have had some from the first also.

In 1 other of the 7 cases infection was most probably acquired by contact.

When divided into 15-day periods, we have the following:

	Number cases using milk.	Number cases using milk from dairy No. 1.
Sept. 1-15, inclusive	2	1
Sept. 16-30, inclusive	1	1
Oct. 1-15, inclusive	3	0
Oct. 16-31, inclusive	8	6
Nov. 1-15, inclusive	19	17
	33	25

Comparisons between different dairies, to be of value, must of necessity take into account the amount of milk sold in proportion to the number of cases of sickness.

From information furnished by the dairymen, it is reckoned that the daily output of milk furnished by the 10 dairies is 1,800 quarts, and for the period of 76 days from September 1, to November 15, would be 136,800 quarts.

Taking this figure as a basis, and computing the amount of milk sold by each dairy, and the number of cases of typhoid for each 100,000 quarts of milk sold, a very good idea is gained of the distribution of cases among the different dairies.

No. of dairy.	Number of cases.	Number quarts milk sold in 76 days.	Ratio of cases per 100,000 quarts of milk.
1	25	18,240	137
2	7	53,200	13
3	0	21,280	0
4	0	4,560	0
5	0	4,560	0
6	0	7,600	0
7	0	9,220	0
8	0	7,600	0
9	0	4,560	0
10	0	6,080	0

Of these 7 cases attributed to dairy No. 2 for the purpose of illustration, as already mentioned, one was probably due to infection by contact, and from the evidence obtained it would not be fair to attribute any of them to infection caused by using this milk.

On the other hand, the 25 cases credited to dairy No. 1 had no other common source of supply for either food or drink, and their infection may be justly attributed to this milk.

It is evident that the number of cases occurring among the customers of dairy No. 1 is out of all proportion to the amount of milk sold. This dairy sold 60 gallons of milk daily, or 13 per cent of the total, and had among its customers 75 per cent of all those patients giving a history of using milk. It would be impossible to explain this upon the ground of mere coincidence.

Further evidence in regard to the milk from dairy No. 1 as being the source of infection is brought out by a comparison between the number of cases occurring among users of this milk and the number of cases occurring among the remainder of the population during the period from October 16 to November 15.

During this period, 27 cases occurred; 23 of these cases were among customers of dairy No. 1, and 4 were not.

Allowing the liberal estimate that each quart of milk of the daily 240 quarts supplied by this dairy was divided among 8 people, we have 23 cases among 1,920 people, or 1 case to every 83, as against 4 cases among 13,000 people (the remainder of the population), or 1 to every 3,250.

Some of the general features of milk-borne typhoid epidemics, as observed in various places by different investigators, are described as follows: There is a special incidence of disease upon the track of the suspected milk supply; better class houses suffer most; milk drinkers are chiefly affected; women and children suffer most; there is a sudden onset, with short incubation period; several cases may occur in the same house about the same time; the attacks are often mild; contact cases are lessened, and the mortality rate is lower than usual.

It would seem that these general features have been quite closely followed out in the series of cases here.

A careful inspection of the suspected dairy was made and measures were recommended for the proper handling of the milk. There was no history of any case of typhoid fever occurring on the place, and no history of any person on the place being associated with a typhoid patient.

To detect a possible bacillus carrier, a Widal test was made of 4 persons on the farm who were employed in handling the milk or utensils. These were all negative for typhoid or paratyphoid. An examination of the stools of 3 people engaged in handling the milk was made, which were also negative for the *Bacillus typhosus*.

Water used for washing the milk bottles and utensils was taken from an open well near the milk house. The water from this well was found to be badly contaminated, the colon bacillus being found in 0.1 of a cubic centimeter at two examinations. Within 4 or 5 feet of this well there ran an underground pipe carrying the discharge from a bathtub in the house, and waste water used in washing the milk utensils.

Again, the method of washing and sterilizing dirty milk bottles was not sufficient to kill the typhoid bacillus, had any been present. It is very possible that dirty bottles returned from the home of a typhoid patient may have been contaminated, and these being washed in the same water with other bottles, and all being filled again without thorough sterilizing, may have served to spread the infection.

Also this contaminated waste water may have found its way into the well from the drain pipe, and the infection further spread from this source.

Whatever the exact source of the infection, it apparently ceased to be operative before or about November 1, for the date of definite onset of the last case of typhoid fever reported was November 12.

No typhoid bacilli were found in the well water or milk, but this is very natural, as the first examination was made about 20 days after the date of onset of the last case of typhoid reported, and about a month from the time we may judge the source of infection to have disappeared.

ICE CREAM.

The occasional use of ice cream was quite general among the 34 cases, the cream being obtained from various sources. No case could be definitely attributed to its use, but there is possibility that this was the source of infection in a few cases not otherwise accounted for.

ICE.

The use of ice can be quite definitely eliminated as a cause of infection, since this product is satisfactorily made from distilled water.

WATER.

The public water supply is obtained from two groups of wells numbering about 46, and from about 30 to 70 feet deep. That portion coming from the Arkansas station is subjected to mechanical filtration, and at this station a reserve supply is kept in a storage reservoir for fire purposes. The daily consumption is about 850,000 to 1,000,000 gallons. This supply is used quite generally in the city as the sole or occasional supply. Besides this, many families have shallow wells, either dug or driven to a depth between 20 to 40 feet.

Among the 34 cases investigated the water supply was as follows:

City water:	
Solely	18
Principally	3
Occasionally	11
Shallow-well water:	
Solely	1
Principally	11
Occasionally	1
Spring water:	
Solely	1
Principally	0
Occasionally	2

In order to judge what part, if any, water has played as a cause of typhoid, 22 bacteriological examinations have been made of samples of the city water and 7 from private sources. Five of these 22 samples were taken at the pumping stations and 17 from centrally located taps.

Fermentation tests were made in lactose bouillon incubated at room temperature for 48 hours. Plates of standard agar, kept at room temperature for 48 hours, were used in making the counts. Endo's plating medium was used for the detection of the colon bacillus from fermentation tubes showing the presence of gas. From these plates typical red colonies of *Bacillus coli* were fished and later fully identified at the Hygienic Laboratory.

Numerous fermentation tubes showed the presence of a small amount of gas, but when plated on Endo's medium no colon-like colonies were found. Many of these colonies which were formed on Endo's medium were later replanted in fermentation tubes but in no instance was gas formed.

This leads to the conclusion that the formation of gas in the original tubes was due to anaerobic bacteria which failed to grow on the plates. On the other hand in 3 instances the colon bacillus was found on plates made from fermentation tubes showing the presence of only a small amount of gas, estimated at less than 10 per cent. This emphasizes the necessity of careful plating out from fermentation tubes showing the presence of only a small amount of gas, to detect the colon bacillus, and shows the error that may arise when relying only upon the presumptive test.

Results of examination of water supply.

Source and date.	Number of bacteria per cc.	Fermentation in lactose bouillon.			B. coli in—		
		10 cc.	1 cc.	0.1 cc.	10 cc.	1 cc.	0.1 cc.
Texas station, before passing pump:							
Dec. 4, 1911	200	.....	.....	.....	.....	.....	.....
Dec. 16, 1911	350	.....	.....	[1]×	.....	.....	.....
Average	275	.....	.....	.....	.....	.....	.....
Texas station, after passing pump, Dec. 4, 1911	225	.....	.....	.....	.....	.....	.....
Arkansas station, after passing pump:							
Dec. 4, 1911	1,500	.....	.....	.....	.....	.....	.....
Dec. 16, 1911	800	[1]×	[1]×	.....	.....	.....	.....
Average	1,150	.....	.....	.....	.....	.....	.....
Central tap on State Line Avenue:							
Dec. 4, 1911	500	.....	.....	.....	.....	.....	.....
Dec. 9, 1911	585	[2]×	[1]×	.....	.....	.....	.....
Dec. 11, 1911	295	×	×	.....	×	×	.....
Dec. 12, 1911	2,100	×	×	.....	×	×	.....
Dec. 16, 1911	545	[1]×	[1]×	[2]×	.....	.....	.....
Average	805	.....	.....	.....	.....	.....	.....
Central tap on Pine Street:							
Dec. 9, 1911	215	×	[1]×	[1]×	×	.....	.....
Dec. 11, 1911	600	×	×	×	×	×	×
Dec. 12, 1911	2,385	[2]×	[1]×	.....	.....	.....	.....
Dec. 13, 1911	1,300	[1]×	[2]×	.....	.....	.....	.....
Dec. 15, 1911	130	×	[2]×	.....	×	.....	.....
Dec. 16, 1911	230	×	[2]×	[2]×	×	.....	.....
Average	810	.....	.....	.....	.....	.....	.....
Tap corner Broad and Pine Streets:							
Dec. 9, 1911	2,185	[2]×	[2]×	[1]×	.....	.....	.....
Dec. 11, 1911	280	[1]×	[2]×	[2]×	.....	.....	.....
Dec. 12, 1911	1,450	×	[2]×	.....	×	.....	.....
Dec. 13, 1911	3,300	×	[2]×	[1]×	×	.....	.....
Dec. 15, 1911	660	[1]×	[2]×	.....	.....	.....	.....
Dec. 16, 1911	765	[1]×	[2]×	[2]×	.....	.....	.....
Average	1,440	.....	.....	.....	.....	.....	.....
Water samples, miscellaneous:							
Well open B—							
Dec. 2	1,933	×	×	×	×	×	×
Dec. 5	1,066	×	×	×	×	×	×
Well closed B, Dec. 5	366	[2]×	[1]×	.....	.....	.....	.....
Well closed C, Dec. 6	300	[1]×	.....	.....	.....	.....	.....
Well open W, Dec. 9	416	×	[1]×	.....	.....	.....	.....
Spring B, Dec. 8	1,110	×	×	.....	×	×	.....
Spring G, Dec. 18	833	×	×	.....	×	×	.....

[1]×—Small amount of gas. Plated on Endo's medium. No colonlike colonies formed.
[2]×—Gas bubble. Not plated.
×—Present,

From the above tables it is seen that the colon bacillus was found in 8 of these samples of city water, or 36 per cent, but for the most part in such large amounts of water (10 c. c.) as not to indicate a very dangerous pollution. Water showing only this degree of pollution could not be considered as the probable cause of a typhoid epidemic.

During the time covered by these examinations the filter was under repair, and the quality of the water may be fairly assumed not to have been up to the usual standard, or equal to that supplied during the month of October and before the unusual prevalence of this disease.

To fairly estimate the quality of the water, it is necessary to take into account the source of the water in connection with the bacteriological examination. Water coming from closed wells at a depth of 30 feet or more should be practically free from contamination with intestinal bacteria unless under very unfavorable surroundings.

Before a water supply can be considered as the prime factor in the causation of a typhoid epidemic it is first necessary to eliminate other possible factors as causes, which can not be done in this case with the milk supply. Thus the assertion is warranted that evidence is lacking that the public water supply has played any appreciable part in the causation of typhoid.

No case could be definitely attributed to the use of water from shallow wells, but this remains the possible source of infection in a few cases not otherwise accounted for. From the few examinations made it would seem that the water obtained from the shallow wells, especially of the open type, was of an inferior quality to that of the public supply.

SUMMARY AND CONCLUSIONS.

To sum up the foregoing, 25 of the 34 cases arising in the city or 73.5 per cent, are attributed to the use of milk from one dairy; one case may be attributed to contact, leaving 8 cases, or 23.5 per cent unaccounted for. The most probable source in these cases is milk, ice cream, or well water.

RECOMMENDATIONS.

Milk and food supplies.—The sale of milk and ice cream should be under the supervision of the city authorities. Those desiring to sell milk and ice cream should be required to take out a license and be subject to inspection. All infectious diseases at the dairy farm should be reported, and the sale of milk should be prohibited when coming from insanitary premises or from places where there are patients suffering from typhoid or other infectious disease if there is the least possibility of contamination.

This requires the attention of a milk inspector whose duty it should be to make inspections of the dairies and instruct the dairymen as to the proper way to secure clean milk.

Pasteurization of milk is urged as the most efficient means of preventing the spread of typhoid from this source. If done in an efficient manner it will kill the germs which may get into the milk from undetected sources.

The practice of keeping foodstuffs exposed for sale, where subject to contamination by flies and street dust, should be prohibited.

Sewerage.—The city sewerage system should be extended as soon as possible, to include those portions of the city not already supplied, and, when available, connections to the sewer should be enforced.

Where sewerage connection is not possible, soil pollution should be limited by replacing the common open privy with one of a sanitary type, so constructed that flies can have no access to it, and its contents can be properly disinfected and disposed of.

Disposal of stable and household refuse.—To limit the prevalence of flies and the spread of disease by this means, careful attention should be given to the removal of their breeding places, which are chiefly in stable and household refuse. The disposal of this refuse should be under the control of city authorities, and frequent removal, at least once a week, is suggested as the most practicable method.

The health department in its relation to typhoid.—Probably the most important factor in the prevention of typhoid fever and other infectious diseases is the vigilance of the health department. The importance of the health department in the welfare of the city should be fully appreciated and adequate provision made for it in the way of equipment.

Typhoid fever should be reported to the health officers as other infectious diseases are, so that they can make investigation as to the cause of the disease and the measures necessary for its control. Instructions should be given as to the proper disinfection of excreta, and where necessary the disinfectant should be distributed free of charge.

Included in the health organization there should be a bacteriologist, with the equipment necessary to make examinations of milk, water, and blood. Blood examinations are most important in the early diagnosis of typhoid fever, especially so in a country where malaria occurs. By this means, also, more accurate information is secured as to the prevalence of the disease and its control made more efficient.